Hydraulic Evaluation of Bureau of Reclamation Fish Release Sites

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Summary

For several years there has been considerable focus and discussion on the performance of fish release sites used by the Bureau of Reclamation (Reclamation) and California Department of Water Resources (DWR). Reclamation and DWR each maintain and operate two to three separate fish release sites at different locations on the Sacramento River. The state and federal release sites are similar in concept, yet all release sites are unique and possess different operating conditions. Fish survival during and following the release process has been the topic of several biological studies. Fish survival is dependent on both biological and hydraulic parameters associated with the release process.

In 2008 DWR conducted a biological and hydraulic assessment of the state water project fish release sites, (Miranda *et al*., 2010). The DWR study evaluated fish survival and hydraulic performance of a DWR release site using a physical hydraulic model and a three-dimensional computational fluid dynamics (CFD) model of the release facility. The study identified several hydraulic issues associated with design and operation of state water project release sites that resulted in improvement actions. Hydraulic issues included turbulent hydraulic jumps, blowback, and insufficient flushing flows within the release pipe. These issues have a significant impact on fish survival inside the pipe due to combined debris loads with turbulence as well as predation at the pipe exit. This proposal addresses the need to conduct hydraulic evaluations of Reclamation's fish release sites.

Problem Statement

Reclamation's fish salvage release sites were designed in the 1950s. Many of the design assumptions that formed the facility's basis-of-design have changed. The release sites were likely designed targeting mainly the restocking of salmon smolts with limited

concern at the time for other fish species or debris load. Public concern for fish survival has now risen embracing the full spectrum of delta and transient fish species encountered at the salvage facility. Debris load entering the salvage facility has also increased, impacting the salvage process at all interfaces of operation.

Goals and Hypothesis(ses)

Goals:

1. What are the flow conditions encountered by fish during the fish release process at each of Reclamation's release sites?

2. How should the release facility be operated to ensure debris and fish are flushed from the pipe?

3. Does operation of the release facility need to be adjusted for pipe submergence based on river stage?

4. How do flow conditions within the release pipe change with changing debris loads or debris types?

5. Where can flexibility be added to the release facility to improve operator control of flow conditions during a release?

Hypotheses:

1. Existing operation during a fish release provides optimum hydraulic conditions for safely restocking fish to the delta.

2. Flow conditions during the restocking operation are similar for all sites.

3. The quantity and timing of providing auxiliary flow during the restocking is well documented and provides for known hydraulic conditions in the restocking pipe.

4. Hydraulic conditions during a release are similar for all fish trucks.

5. Similar hydraulic conditions during the restocking process occur for all drivers and times of day.

6. Operation of the release is independent of debris load.

Materials and Methods

The study will be conducted by hydraulic engineers from the Denver Technical Center Hydraulics Laboratory in consultation with fishery biologists from the Technical Service Center (TSC) and TFCF. The study should start in October 2010 and will take a year. The CFD program FLOW-3D will be used for the numerical simulations. FLOW-3D is a widely accepted program used for the modeling of unsteady free surface flow. The

program is routinely used by Reclamation Hydraulics Laboratory engineers to investigate complex hydraulic conditions.

The study will be conducted in two phases. (1) Existing drawings of the release sites will be located and visits made to each site to verify and update drawings to reflect the current facilities. A second trip to each site will then be conducted to witness a fish release and collect additional data on operation. Instrumentation will be installed prior to a release to record a time sequence of events, truck fish tank water pressure, release gate operation, auxiliary release flow, river stage and air flow rate into or out of the release pipe. (2) Data collected from each site will be used in the development and calibration of 3-dimensional CFD models of each release facility. The models will be designed to simulate the time variant release of flow from the fish haul truck through the release facility. The models will include auxiliary water supplied during the release, tailwater submergence and the flow velocity field imparted by the river surrounding the near field of the pipe outlet. The numeric models will be used to evaluate hydraulic conditions in the truck, release pipe and at the pipe outfall for the normal range of release conditions including river stage. The model will be used to identify hydraulic conditions during a release based on current practice, identify areas of poor performance and define changes that can improve fish survival during restocking.

The study will include simulations of present practice during a fish release followed by simulations of proposed improvements to operations and release site infrastructure. Debris load cannot be directly modeled. However, movement of solids entrained in the flow can be modeled. Solids can be described by volume and density thus permitting flushing of simulated debris to be analyzed.

Coordination and Collaboration

The study will be coordinated with the operations manager and fisheries research staff at TFCF.

Endangered Species Concerns

The study will not affect "Take" as we are not altering the fish release operation during the study.

Dissemination of Results

We will produce a volume in the Tracy Technical Report Series as the expected deliverable from the study.

Literature/Cited

Mefford, B.W. 2008, - CHTR *Fish Release Study - fish release pipe hydraulic analysis*, USBR Water Resources Research Laboratory, Paper PAP 985.

Miranda, J., R. Padilla, G. Aasen, B. Mefford, D. Sisneros, and J. Boutwell. 2010. *Evaluation of Mortality and Injury in a Fish Release Pipe*. California Department of Water Resources, Bay-Delta Office